A SURGICAL GUIDE FOR USE DURING SINUS ELEVATION SURGERY UTILIZING THE CALDWEL-LUC OSTEOTOMY

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FIELD OF THE INVENTION

The present invention relates generally to the field of oral implantology in the surgical reconstruction of the maxillary sinus in preparation for dental implant placement. More particularly, the present invention relates to a surgical guide and accompanying bur utilized to guide the surgeon in preparation of the osteotomy to enter the maxillary sinus as part of the procedure of sinus elevation and grafting.

BACKGROUND OF THE INVENTION

Following maxillary posterior tooth loss, the maxillary sinus pneumatisizes or expands in every dimension towards the maxilla. As the maxillary bone resorbs, the sinus is enlarged in a coronal, lateral, anterior and posterior direction. This pneumatization, or expansion of the maxillary sinus resulting from maxillary bone resorption, leaves less maxillary bone for a platform on which to place dental implants. If enough maxillary bone has resorbed, placement of a dental implant would penetrate the floor of the sinus and leave the apical portion of the implant into the sinus and, thus, not engaged in bone. This would result in no bony support around that portion of the implant and negate the purpose for dental implant placement as a means of tooth replacement in the posterior maxilla.

In preparation for dental implant placement in the posterior maxilla the clinician must evaluate the position of the maxillary sinus relative to the remaining maxillary bone and whether bone resorption has occurred to the point of leaving insufficient amounts of bone for implant placement. If it is determined that insufficient bone exists for placement of dental implants due to the expansion of the maxillary sinus, then a sinus elevation and grafting procedure is indicated prior to implant placement.

The prevalent method of sinus elevation and grafting is called the Caldwell-Luc Osteotomy. The procedure involves reflecting a full thickness mucosal flap to expose the lateral wall of the sinus and maxilla. A lateral osteotomy is then prepared in the lateral wall of the maxillary sinus. The osteotomy is rectangular in shape and is cut as deep as

the lateral wall of the maxillary sinus until the sinus membrane (Schneiderian membrane) is exposed. The window, or osteotomy, is then carefully tapped medially to allow entry into the sinus cavity. Afterwards, the sinus membrane is gently elevated from the floor and the anterior and posterior walls of the sinus utilizing various blunt dissecting instruments. After the sinus membrane has been elevated and retracted apically and medially, bone is then placed in the area that has been elevated. The mucosal flaps are then approximated and sutured.

One of the technical difficulties encountered during this procedure is the inability of the operator to precisely locate the floor of the sinus as he prepares the osteotomy from an antero-posterior direction (along the X-Y axis). Since the floor of the sinus can elevate and descend variably as the osteotomy moves antero-posteriorly, it is impossible to visualize this course. Therefore, the osteotomy is generally prepared in a straight line higher than the highest point of the sinus floor. This guarantees penetration into the sinus floor since an osteotomy that is lower than the sinus floor at any point will simply penetrate into the maxillary bone and not into the sinus cavity. This would require adjustment by expanding the osteotomy superiorly (apically) in order to penetrate the sinus cavity. Obviously, the additional trimming of bone is traumatic and removes bone unnecessarily. Another error occurs if the osteotomy is placed too superior to the floor of the sinus. Very careful manipulation must then be effected in order to negotiate the remaining lateral wall of the sinus inferior to the osteotomy and to descend below the Schneiderian membrane in order to elevate it from the sinus floor. This technically difficult maneuvering of the instruments along two planes increases the risk of tearing the membrane and thus compromising the outcome of the graft. Otherwise, the osteotomy

must be adjusted by expanding in an inferior direction. This would lead to additional trimming of bone and increase the risk of tearing the membrane during the expansion of the osteotomy. It is nearly impossible to visualize the variable course of the sinus floor as the osteotomy progresses antero-posteriorly. This inability to visualize the course of the sinus floor is the first difficulty encountered in the procedure.

Another difficulty encountered is the varying thickness of the lateral wall of the sinus as the osteotomy penetrates it to expose the underlying schneiderian membrane. The operator must penetrate fully through the lateral wall (X-Z axis) in order to raise the window and elevate the membrane. However, if the osteotomy is prepared too deep, it can tear through the fragile membrane. Therefore, great operator skill is required to visualize the membrane as the osteotomy is prepared through a varying depth of the lateral wall and the membrane is approached.

A further difficulty encountered is the anterior wall of the sinus. Besides the varying depth of the lateral wall, the anterior wall can also vary in course in the Y-X axis **(FIG 2)** just as the floor can vary in course in the X-Y axis **(FIG 2)** and the lateral wall can vary in thickness in the Y-Z axis **(FIG 3)**. Since the osteotomy usually is placed in a straight line apico-coronally (vertically), whereas the anterior wall is usually not a straight line, portions of the osteotomy would be too far posterior to the anterior wall. This would require manipulation anteriorly and then laterally to dissect the membrane from the lateral and anterior walls thus increasing the risk of tearing the membrane from the difficult manipulation in two planes. Again, any additional adjustments to the osteotomy would cause unnecessary bone removal and trauma as well as increase the risk of tearing the membrane.

Most of this technique relies on the careful approximation of the outline of the area of the sinus to be grafted. The osteotomy planned should be inside the sinus borders for reasons explained above. Since it is nearly impossible to accurately follow the varying course of the sinus during the osteotomy, inevitably there would be areas that are not exposed by the osteotomy. This would require the careful manipulation of the sinus membrane which risks damage to the membrane. Furthermore, as the lateral wall of the sinus is being cut, the varying thickness of the lateral wall requires that the surgeon proceed very carefully and rely on visual as well as tactile senses to establish that the wall has been pierced without entering the sinus so as to not damage the immediately underlying membrane.

One of the most reliable methods to graph the maxillary sinus in three dimensions is the Dentascan, which is a CT scan that renders the sinus in the X, Y and Z planes. The Dentascan can then be formatted for evaluation utilizing Simplant software. Simplant is a software which allows the clinician to view the sinus in all dimensions as well as to manipulate the image and prepare a treatment plan as to the location and amount of bone to be grafted in the sinus in order to augment the missing maxillary bone that the sinus has expanded into. This information can then be utilized by the surgeon to establish the parameters of outline and volume of the area of the sinus to be entered for bone grafting.

Even with the information provided by the Dentascan utilizing the Simplant software as to the outline of the sinus in the X, Y and Z planes and all other parameters, there has been no mechanism to accurately transfer this highly precise information to the surgical field. Meticulous planning of the parameters of the sinus to be elevated and

augmented has been thwarted by the inaccurate approximation in the transfer of this information during the surgical procedure.

There has thus been a gap between the extremely precise diagnostic information and treatment planning obtained by the Dentascan and Simplant software, and the accurate transfer of that information into the surgical field to aid the surgeon in executing such a treatment plan.

Accordingly, the objects of the device and method of the present invention are to overcome the limitations and drawbacks of the prior art and make a significant contribution to the state of the art of reconstructive surgery of the maxillary sinus by providing a surgical guide and bur and a specific method of use wherein the guide has the advantages associated with transferring precise data obtained from a Dentascan utilizing Simplant software into the surgical field and aiding the surgeon in such surgery.

BRIEF SUMMARY OF THE INVENTION

The invention described discloses a surgical guide and accompanying surgical bur with a ledge for depth control. The guide is fabricated from acylic and is based on the treatment plan set forth from the diagnostic information provided by the Simplant

software from a Dentascan taken of a patient. It allows the surgeon to accurately prepare a Caldwell-Luc osteotomy in all three planes. The outline of the osteotomy as well as the depth of the bone to be removed without damaging the underlying the Schneiderian Membrane is created utilizing the surgical guide and proper depth bur. This would enable open access to the maxillary sinus cavity within the dimensions required for the sinus elevation and enable the surgeon easy access to the Schneiderian Membrane without anatomical obstructions. Previously, this procedure was performed merely with an approximation as to where the floor of the sinus was, where the superior portion was, as well as where the anterior wall and the posterior wall were. In addition, the variable depth of the lateral wall of the sinus was accessed only with the experience and visual sense of the clinician without exact measurements as to the varying thickness of the osteotomy as it moved along the x-y axis. The proposed surgical guide would eliminate all approximations of the osteotomy in the x-y axis as to the outline of the osteotomy as well as the Z axis as to the depth of the osteotomy so as to prevent any damage of overcutting into the Schneiderian Membrane and thus enabling easy access into the sinus cavity as outlined by the treatment plan set forth utilizing Simplant software from a Dentascan of the patient's maxillary sinus.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig **1** is an image from a dentascan showing three views.

Fig. **2**shows a panoramic view of the maxilla showing the sinus (**S**) and **X-Y** axes.

Fig. **2A** is the same panoramic view as fig **2** showing the design of the area to be grafted **G** as well as the **X-Y** axis. **A** is the apical portion of the area to be grafted. **C** is the coronal portion. **M** is the mesial, or anterior, portion. **D** is the distal, or posterior portion of the area of the sinus to be grafted.

Fig. **3** shows cross sectional views of the maxilla and sinus at 1 mm intervals. Arrow **B** indicates the buccal, or lateral, wall of the sinus. Arrow **F** indicates the floor of the sinus. Arrow **M** indicates the maxillary bone.

Fig. **3A** is the same cross section as fig. **3** showing the design of the area to be grafted **G** as well as the **Y-Z** axis.

Fig. **3B** is the same cross section as fig. **3** with guide, **GU,** in position showing the apical (arrow **A**) and coronal (arrow **C**) borders of the osteotomy within the guide. The ledge (**L**) maintains the standard thickness of 10 mm to penetrate the buccal wall (**B**) of the sinus.

Fig. **4** shows the surgical bur **SB** with measurement from cutting endpoint (**E**) to depth guide (**G**).

Fig. **5** shows the guide in position on the maxilla with the surgical bur, **SB,** in place resting on the ledge (**L**) of the guide in order to penetrate the sinus along the apical portion of the osteotomy .

Fig. **6** is a panoramic view of the guide **G** in position showing the outline of the osteotomy with the coronal **C**, apical **A,** anterior **ANT**, and posterior **P** aspect of the osteotomy.

Fig. **7** is the same cross sectional view of Fig. **3B** showing the lateral wall of the sinus after the osteotomy (**O**) has been prepared.

Fig. **8** is the surgical guide with the outline of the osteotomy to be prepared with apical wall (**A**), inferior, or coronal, wall (**C**), anterior wall (**A**) and posterior wall (**P**).

DETAILED DESCRIPTION OF THE INVENTION

In the oral cavity, when there is tooth loss, the maxillary sinus pneumatisizes, meaning that there is resorption in a three dimensional plane. The floor of the sinus drops towards the oral cavity, as well as resulting in expansion of the lateral walls. This

leaves less maxillary bone for placement of an implant to replace the missing teeth. If the remaining maxillary bone is insufficient to support an implant in terms of height and width, then sinus elevation and bone grafting is required in order to regain the resorbed bone. The treatment planning for the sinus elevation involves the patient to receive a Dentascan which provides different views of the sinus and maxillary bone (**Fig.1).** This diagnostic information allows the surgeon to prepare a treatment plan which outlines the volume and borders of the area of the sinus to be grafted (**Fig. 2A and 3A).**

One method, which is prevalent is the Caldwell-Luc Osteotomy. This procedure involves opening a window in the lateral wall of the sinus (**Fig. 7**) and then elevating the sinus membrane (Schneiderian Membrane) in order to place a bone graft to replace the resorbed bone in the floor and lateral wall of the sinus.

The outline of the osteotomy is dictated by the area that is required to be grafted. Since it is a three dimensional osteotomy, there is an X, Y and Z component in the plane of the osteotomy. The X and Y component outlines the apical, coronal, mesial and distal aspect of the osteotomy (**Fig. 6**). The Z component outlines the depth of the osteotomy as dictated by the thickness of the lateral wall of the sinus (**Fig. 3**). As a surgeon prepares the osteotomy, he approximates the height of the floor of the sinus as it varies as he travels anteroposteriorly (**Fig.2**). Furthermore, he approximates the mesial (anterior) extent in a coronal-apical direction as well as the distal (posterior) extent in a coronal-apical direction. He also approximates the occlusal outline of the osteotomy as it connects the mesial and distal (anterior and posterior) walls of the osteotomy (**Fig. 6**). More importantly, he must then determine the depth laterally, along the Z axis, of the osteotomy within his outline (**Fig. 3**) so as to penetrate up to the Schneiderian Membrane.

This lateral depth varies as he moves along the X-Y plane along the outline form. The methodology traditionally available is the surgeon's view of the color of the bone as it changes as he approaches the piercing of the lateral wall and sees the grey Schneiderian Membrane.

After the surgeon has cut the outline form of the osteotomy and penetrated the lateral wall of the sinus (**Fig. 7**), he begins to elevate the membrane from the floor of the sinus and graft bone in the site. Rarely, does the surgeon place his osteotomy exactly on the floor of the sinus (the coronal border) and along the exact anterior border of the sinus. Therefore, he/she must maneuver the instruments as to separate the membrane from the sinus floor and anterior and posterior walls as there is inevitably a shelf of bone to negotiate.

To assist the surgeon in visualizing the outline of the sinus in three dimensions, a patient can have a Dentascan performed and formatted in a computer program called Simplant which gives different views of the X, Y and Z planes of the sinus (**Fig. 1**). This allows the surgeon to visualize the different walls of the sinus and their exact depths and outline for the osteotomy. Furthermore, the exact outline in the X-Y axis (antero-posteriorly) can be drawn and planned so the osteotomy is exactly at the floor of the sinus regardless of variations in height as the osteotomy travels along the X axis (**Fig. 6**). In addition, the anterior and posterior walls of the osteotomy can be charted so they follow along the exact walls of the sinus, thus leaving no shelves for the sinus elevation instruments to negotiate. The superior wall is also outlined as necessary by the height of bone required to be grafted. Finally, and no less important, as the osteotomy moves along the X-Y plane in preparing the window, the depth of the osteotomy, as dictated by

the thickness of the lateral wall (the Z axis) (**Fig.3b**), can also be accurately measured as it varies along the X-Y plane. All this information can be planned as well as visualized by the surgeon, prior to surgery, utilizing the Simplant software. However, up to date, there has been no available mechanism to transfer this information into a reliable guide for the surgeon to follow the parameters he/she has outlined in the treatment plan.

It is thus proposed that a surgical guide (**Fig. 8**) is fabricated from acrylic that will replicate the parameters outlined by the surgeon according to the plan proposed utilizing the Simplant software obtained from a Dentascan. These parameters will assist in preparation of a Caldwell-Luc osteotomy that is appropriate to the treatment plan set forth by the surgeon in the X-Y and Z axes, thereby transferring the information from the computer to a guide that can be utilized during the surgical procedure. The guide is to be seated on the alveolar ridge after dissection of the mucosa. The seat is a stable seat without movement. A bur with a depth guide is then utilized to prepare the osteotomy within the outline of the window inside the surgical guide(**Fig. 4, and Fig.5**). The bur is to rest on the ledge within the window of the guide so as to maintain a constant cutting depth and not penetrate too far inside the sinus (**Fig. 5**). After the osteotomy has been prepared, the bone within the window of the osteoetomy is elevated as the sinus is entered for elevation and grafting (**Fig. 7**).